

THE LONGITUDINAL HEALTH STUDY:  
A Multiphasic Medical Surveillance Program  
for U. S. Navy Submarines and Diving Personnel

by

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NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY  
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## SUMMARY PAGE

### THE PROBLEM

To establish and operate a longitudinal surveillance system for submarine and diving personnel to identify biological and psychological effects of their specialized occupational exposure.

### FINDINGS

Multiphasic health data collection is ongoing at the Naval Submarine Medical Research Laboratory on a daily basis. Data is being stored on computerized magnetic tape for immediate multivariate analysis and for longitudinal compression.

### APPLICATION

The health profile which is being developed will be valuable to those medical personnel who monitor the habitability of submarines, to engineers who design submersible habitats and escape vehicles, to those scientists seeking to understand variables of the aging process, and to those who seek to protect the government against false claims relative to damage to personnel allegedly arising from such exposure.

### ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Bureau of Medicine and Surgery Research Work Unit MF51.524.006-1002BF91. This present report is No. 2 on this work unit. It was received for review on 26 April 1974, approved for publication on 31 May 1974, and designated as NavSubMedRschLab Report No. 786.

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## ABSTRACT

The Longitudinal Health Study is an ongoing medical surveillance program which is designed to analyze multiphasic health parameters among submarine and diving personnel occupationally exposed to specialized environmental stresses. Traditional as well as specialized health data is tabulated on Hollerith cards for immediate editing and storage and for ultimate retrieval and multivariate analysis. Anticipated and unanticipated biological effects of specialized environmental stresses will be identified with the goal of controlling them. The present report updates previous descriptions by redefining and illustrating the biomedical content of each phase of the study.

## LONGITUDINAL HEALTH STUDY

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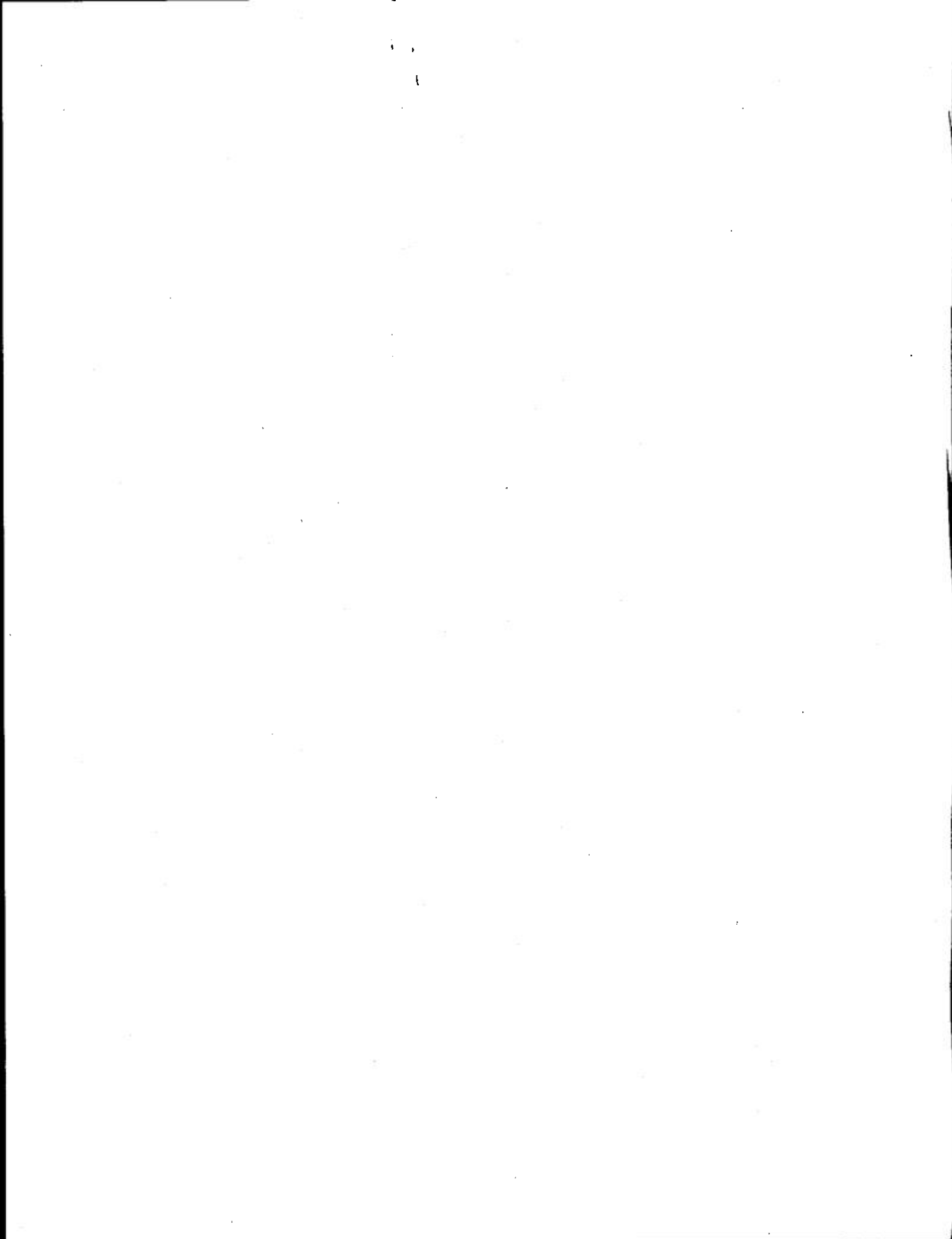
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THE LONGITUDINAL HEALTH STUDY:  
A Multiphasic Medical Surveillance Program  
For U.S. Navy Submarine and Diving Personnel

INTRODUCTION

Application of nuclear power to submarines brought about the first completely underwater circumnavigation of the globe in 1961. Since then the Nuclear Power program has developed at an exciting pace. The size of these underwater weapons, their strategic potential, and technological flexibility continue to advance. Life support systems have become increasingly sophisticated so that the physical capability for prolonged submergence continues to improve. Driven by man's unceasing quest to explore the undersea world, engineers are developing miniature submersibles and diving habitats for use at ever-increasing depths, and physiologists are beginning to better understand the extremes of man's physiologic reserve in coping with hyperbaric environments.

In the routine performance of their jobs, many U.S. Navy personnel are exposed to these challenging and confining environments. Yet, to date, there has been no single medical group charged with the responsibility for the development and operation of a longitudinal surveillance system for monitoring both anticipated and unanticipated biological effects. The Longitudinal Health Study is being developed by the Naval Submarine Medical Research Laboratory (NSMRL), Groton, Connecticut, in response to this need.

The Longitudinal Health Study is a multiphasic screening survey which is at present being applied to a randomly selected portion of the U.S. Navy's submarine and diving communities, by the research staff at NSMRL. The project was conceived in 1966 and has since developed into an ongoing research program funded by the Bureau of Medicine and Surgery. Traditional and experimental health information is collected by physicians and medical technicians and is tabulated on data cards for computer editing, storage, and ultimately multivariate statistical analysis. While the long range objective of the project is to identify occupational health trends within two highly specialized populations, submariners and divers, the immediate aim is to identify the incidence of subclinical disease and medical risk factors by the application of multiple test procedures. Both goals constitute a continuing effort toward the improved health, safety and well-being of submarine and diving personnel.

HISTORY

Precedent for this type of research was established in the Navy with the initiation of the Thousand Aviator Study, a health screening program for Naval Aviators which focussed particularly upon cardiovascular changes. A monograph on this study, published in 1965 by the Naval Aerospace Medical

Institute (NAMI), described 25 years of continuing periodic medical examinations based upon an increasingly broad spectrum of biologic variables.<sup>1</sup>

A descriptive report presented by Sawyer and Baker<sup>2</sup> emphasized the evolution of the Longitudinal Health Study and gave particular attention to the content and format of the existing computer editing and storage programs. Since the publication of that report, almost all aspects of data collection for the study have been finally settled on for an initial study group.

The present report will update the previous description and will outline the multiphasic program through which over 600 volunteer subjects have been processed. The reader is referred to Sawyer's report<sup>2</sup> for detailed descriptions of the computer data-coding techniques. The present report will define the current biomedical content of each phase of the survey. Each phase will be identified with the appropriate computer indices under which the data is processed. Accompanying Tables simplify the content of some phases for the purpose of illustration and easy reference.

#### BACKGROUND (INDEX 001-002)

This first section documents essential demographic information including date of birth, geographic origin, family size, years of military service, occupation, pay grade, and years of special military qualification (e.g., submariner, diver, parachutist, etc.). Divers outline their previous specialized diving training and field experience. The information in this section will ultimately provide the guidelines along which

sample populations will be divided into subsets for comparative statistical analysis.

#### PSYCHOLOGICAL/SOCIAL (INDEX 011)

The Minnesota Multiphasic Personality Inventory (MMPI) is a well standardized objective test which has been used as a psychometric "tool" for characterizing the personalities of many diverse sample populations. The test is designed and validated for delineating a variety of broad psychopathological syndromes rather than more specific maladjustive patterns. Voluminous amounts of narrative data have been collected since the test's introduction in 1943.<sup>3</sup> The personality inventory is easily administered and scored and is therefore ideally suited to the purpose of the LHS.

The MMPI consists of 566 true-false statements. Scores for each of the 10 clinically diagnostic subtests and 3 validity scales are obtained by means of a hand-scoring template. The diagnostic subtests are listed in Table I, together with definitions from Hathaway and Meehl.<sup>4</sup>

The General Classification Test (GCT) scores, the number of years of schooling, handedness, number of marriages, and the sex distribution of progeny are all noted in this section for future correlative study.

#### MORTALITY INFORMATION (INDEX 013)

A blank questionnaire requesting pertinent details of a subject's death is included in each health jacket. A brief statement of time of death and of



TABLE I. OUTLINE OF PSYCHOLOGICAL AND SOCIAL TESTING, INDEX 011

---

MMPI:

Diagnostic Subtests

HYPOCHONDRIASIS (Hs)	- Exaggerated anxiety or concern about one's health.
DEPRESSION (D)	- Feelings of worthlessness and hopelessness.
HYSTERIA (Hy)	- Incidence of ailments such as headaches which may have no physical basis.
PSYCHOPATHIC DEVIATION (Pd)	- Antisocial and amoral conduct.
MASCULINITY-FEMININITY (Mf)	- Measure of masculine (as apposed to feminine) interests, values, and emotional traits.
PARANOIA (Pa)	- Suspiciousness of others' motives based upon irrational beliefs and attitudes.
PSYCHASTHENIA (Pt)	- Irrational compulsive acts and obsessive thoughts.
SCHIZOPHRENIA (Sc)	- Withdrawal trends often with hallucinatory and bizarre aspects.
HYPOMANIA (Ma)	- Irrational elation and excitement.
SOCIAL INTROVERSION (S)	- Avoidance of social contacts.

Validity Scales

L - SCALE	- Measures inordinate deceptive tendencies in responding to certain items.
F - SCALE	- Measures tendency to distort responses in the direction of making one self "look bad" on the test.
K - SCALE	- Measures guardedness or defensiveness in test-taking attitudes.

OTHER:

GENERAL CLASSIFICATION TEST (GCT) SCORES.

NUMBER OF YEARS OF SCHOOLING.

HANDEDNESS (Right, left, ambidextrous).

NUMBER OF MARRIAGES.

NUMBER OF NATURAL MALE AND FEMALE CHILDREN, RESPECTIVELY.

primary and related causes of death will lend some insight into disease prevalence within the specialized populations being studied. A mechanism has yet to be established to ensure the proper return of the completed forms to a central facility.

#### ANTHROPOMETRIC (INDEX 015)

General anthropometric data on submariners and divers is not readily available at the present time. The pertinence of these measurements to designers of diving and submarine escape suits and devices as well as to engineers of escape hatches and submersible habitats must be emphasized. Seventeen anthropometric measurements have been selected with the advice of Mr. Robert White of the Anthropometric Section, Army Environmental Laboratory, of Natick, Massachusetts. All of the measuring techniques illustrated in Figure 1 conform with the criteria outlined in White's current publications.<sup>5-6</sup>

Weight: Each subject is weighed to the nearest pound.

Skinfold: Three areas are measured on the right side of the body: (1) midway between the right acromial process and the olecranon (triceps), (2) at the inferior tip of the scapula (subscapular), and (3) at the right midaxillary line at the level of the umbilicus. Measurements are made with a Lange skinfold caliper which is applied to a skinfold taken parallel to the natural folds of the area.

Circumferences: Chest circumferences (maximal inspiratory and maximal expiratory), waist circumference, and vertical trunk circumference

(standing) are measured with Keuffel and Esser Wyteface tape.

Linear Parameters: Length, height, and breadth are measured with GPM anthropometers except the foot length which is measured in a foot measuring box. The relative lengths of the first and second digits of the right foot are noted.

#### ROENTGENOGRAPHY (INDEX 020)

Each participant receives a routine 14 X 17 inch chest x-ray. Only when there is a question of diagnosis is a companion lateral exposure obtained. Each x-ray is reported under one of four general diagnostic categories: within normal limits, old calcification, cardiomegaly, or other abnormality. When a diver undergoes long-bone x-rays as prescribed for the Navy's survey for dysbaric osteonecrosis ("Aseptic Bone Necrosis")<sup>7</sup>, both the results of the x-rays and the fact that they were or were not accomplished are coded in this index.

Total lifetime occupational radiation exposure as well as the total number of months of exposure are transcribed directly from the Form DD 1141 which is included in each participant's military health record.

#### DENTAL (INDEX 021)

The majority of sick call visits for dental problems documented on submarine patrols grow out of poor oral hygiene and resulting gingival infection. A comprehensive dental examination has been designed to incorporate a qualitative assessment of current

periodontal health, and to develop a system of measurements which are reproducible and pertinent to longitudinal analysis. The number of decayed, missing, or filled teeth and tooth surfaces is counted and recorded as is the number of pockets. Pocket or sulcus depth is measured on six teeth with a calibrated probe and the extent of debris and plaque formation is measured on the same teeth. A Periodontal Index (modified Russell's Index) quantitatively reflects the periodontal condition for all teeth.<sup>8-9</sup> The Simplifier Oral Hygiene Index of Greene and Vermillion is based upon a numerical determination of debris found on four posterior and two anterior tooth surfaces.<sup>10-11</sup> The Periodontal Disease Index (modified Ramfjord Index) combines measures of sulcus or pocket depth with a numerical determination of plaque formation.<sup>12-13</sup> Finally, color photographs with and without erythrocin staining, maxillary and mandibular plaster impressions, and bite-wing and Panorex x-rays permanently document the state of oral health for present evaluation and for future comparison. The dental examination is summarized in Table II. Because this section of the examination is disproportionately time-consuming, it has not been possible to study all of the program's participants. Approximately 30% of the subjects are included.

#### PULMONARY FUNCTION (INDEX 025 & 026)

At the present time, traditional spirometry is being performed with a Collins 1253T Residual Volume Spirometer.<sup>14</sup> Status lung volumes are measured with the subject sitting. Following measurement of tidal breathing, the

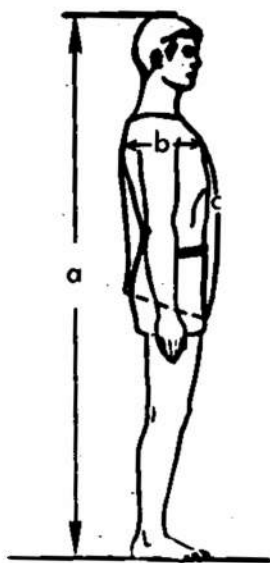
subject performs a maximal expiration, a maximal inspiration, and maximal inspiration followed by a maximal expiration. Each maneuver is performed twice. The larger volume of each pair of measurements is corrected to body temperature and pressure saturated (BTPS) to determine the lung volumes depicted in Figure 2. Residual volume is measured by a helium dilution technique.<sup>15</sup>

With the subject standing, the better of two forced expirations is selected to derive forced expiratory volume 0.5, 1, 2, and 3 seconds, and maximum midexpiratory flow rate (25-75%). Finally, maximum voluntary ventilation is measured over two 12-second intervals and again the better value is selected. (See Figure 3.)

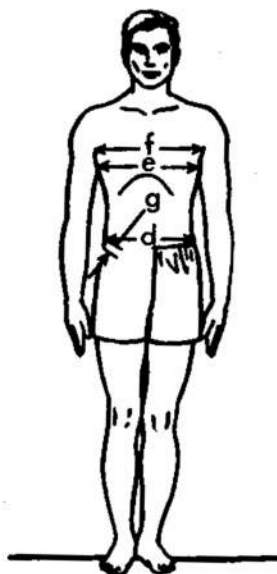
Each of the measurements is stored on a computer printout which includes percentage comparisons with predicted values.

#### AUDIOMETRY (INDEX 031-033)

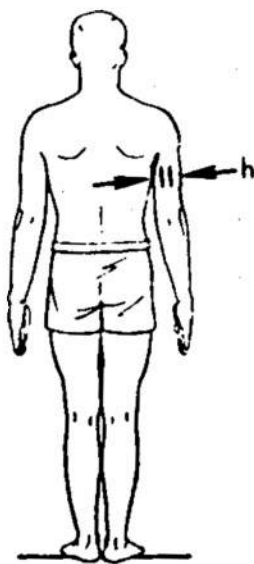
The audiometric protocol combines routine testing of hearing thresholds in the usual functional frequency ranges with evaluation of high frequency responses, pitch memory, and bone conduction. Each subject is individually enclosed in a sound isolated booth for both the air- and bone-conduction studies. Pure tone air-conduction audiometry for hearing thresholds in the frequency range 500-8000 Hertz is accomplished with a Maico Audiometer (Model MA-24). Bone-conduction thresholds for frequencies ranging from 500 to 4000 are measured with the same device. These measurements of bone-conduction patterns allow more specific



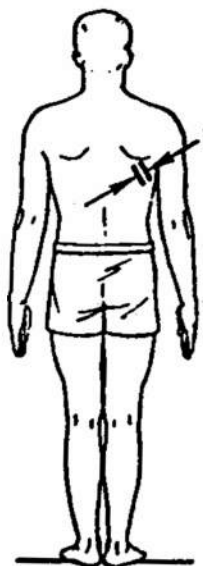
- a. Stature
- b. Chest Depth
- c. Vertical Trunk Circumference  
(Standing)



- d. Waist Circumference
- e. Chest Circumference  
(Inspiration & Expiration)
- f. Chest Breadth
- g. Suprailiac (Midaxillary) Skinfold

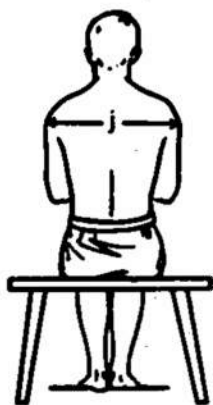


- h. Triceps Skinfold



- i. Subscapular Skinfold

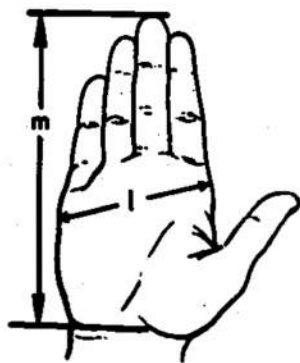
*Figure 1. Anthropometric Measurements, Index 015, Sheet 1*



**J. Shoulder Breadth  
(Bideloid Breadth)**



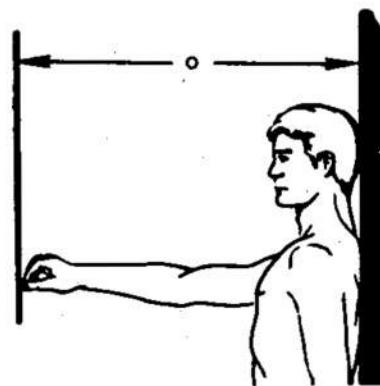
**k. Sitting Height**



**l. Hand Breadth  
m. Hand Length**



**n. Foot Length**



**o. Functional Reach**

*Figure 1. Anthropometric Measurements, Index 015, Sheet 2*

TABLE II. OUTLINE OF DENTAL EXAMINATION, INDEX 021

I. DMFT(s) = Number of Decayed, Missing or Filled Teeth (Surfaces):

Caries  
Restored Teeth  
Missing Teeth

II. Area Gingivitis = Average Score for all Teeth:

Score - 0 : no gingivitis  
1 : mild gingivitis not circumscribing tooth  
2 : gingivitis circumscribing tooth

III. Total Number of Pockets:

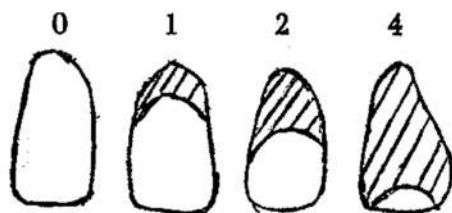
A sulcus is a "pocket" when it is greater than 4 mm.



IV. Modified Russell's Index = Average Gingival Score + Average Score for Pocket Depth

Score - 0 : where pocket depth is 0 - 3 mm.  
5 : where pocket depth is 4 - 5 mm.  
8 : where pocket depth is 6 - 8 mm.

V. Simplified Debris Score of Greene and Vermillion: Average of 6 Teeth:



Score

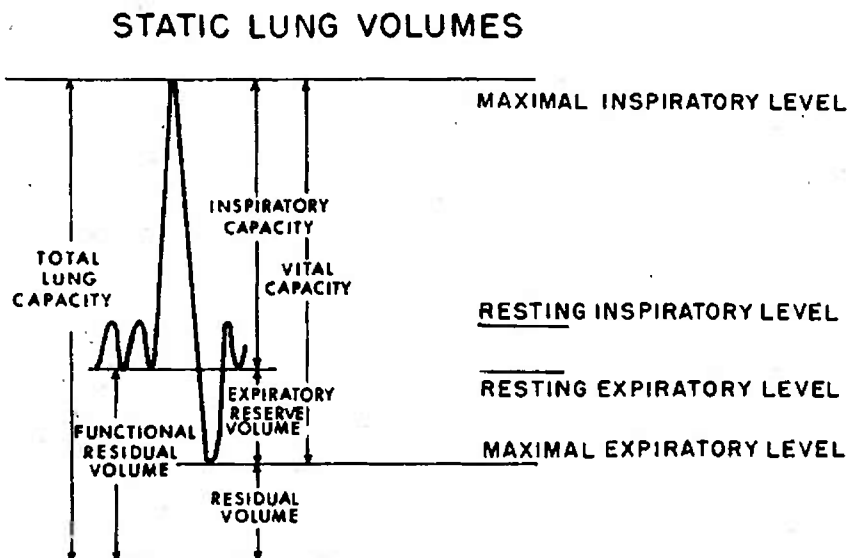
0 No debris.  
1 Soft debris < 1/3 surface.  
2 Soft debris < 2/3 surface.  
3 Soft debris > 2/3 surface.

VI. Periodontal Disease Index (Modified Ramfjord Index):

A. Pocket or Sulcus depth measured to nearest millimeter.

B. Plaque Score for same teeth after erythrocin staining.

Score - 0 No Plaque  
1 Up to 1/3 surface covered.  
2 Up to 2/3 surface covered.  
3 Greater than 2/3 surface covered.

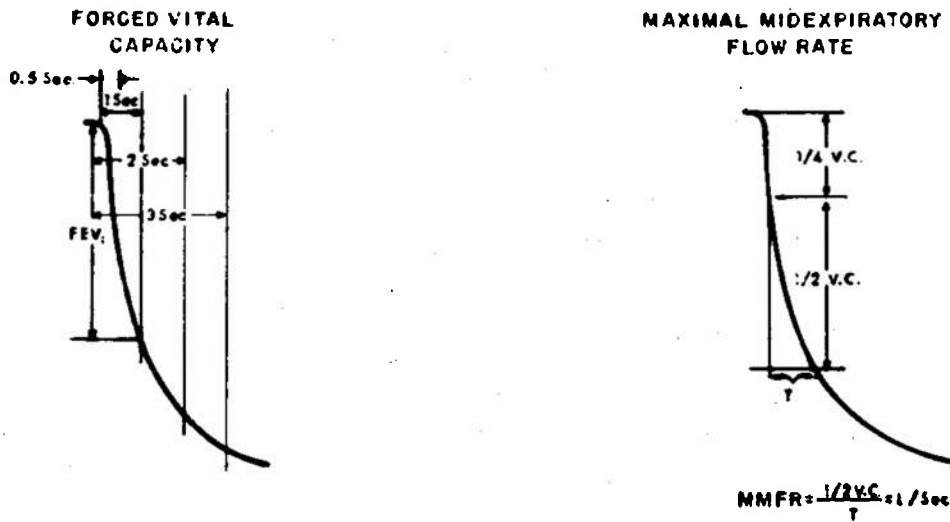


VITAL CAPACITY  
 FUNCTIONAL RESIDUAL CAPACITY (FRC)  
 TIDAL VOLUME (TV)  
 TOTAL INSPIRATORY CAPACITY (TIC)  
 EXPIRATORY RESERVE VOLUME (ERV)  
 RESIDUAL VOLUME (RV)  
 TOTAL LUNG CAPACITY (TLC) as liters and as percent  
 of predicted TLC.  
 RV/TLC

Measurements  
 of anatomical  
 lung volumes.

Figure 2. Static Lung Volumes, Index 026

## FORCED EXPIRATORY RATES



BTPS CONVERSION FACTOR

BODY SURFACE AREA

FORCED VITAL CAPACITY (FVC) as liters and as percent of predicted FVC.

FORCED EXPIRATORY VOLUMES (FEV) 0.5, 1, 2, 3 seconds, as liters and as percent of FVC.

MAXIMUM MIDEXPIRATORY FLOW RATE (MMFR) as liters/minute and percent of predicted MMFR

For detection of functional disorder such as Bronchitis, Asthma, etc.

Figure 3. Forced Expiratory Rates, Index 025



A Rudmose High Frequency Audiometer (Model RA-114 m HF) tests threshold responses to frequencies ranging from 4 kHz to 18 kHz. Decrements in high frequency response can be associated with age as well as with drugs or with acoustic trauma. Such sensitive physiological evaluation is thought to be particularly pertinent to longitudinal health analysis.

TABLE III.  
OUTLINE OF AUDIOMETRIC TESTING, INDEX 031-033

	<div> frequencies in Hertz </div>		<div> frequencies in Hertz </div>
	500		500
	4000		3000
AIR	1000	BONE	
CONDUCTION	6000	CONDUCTION	1000
THRESHOLDS	2000	THRESHOLDS	4000
	8000		2000
	3000		

	<div> frequencies in kiloHertz </div>	
HIGH	4	12
FREQUENCY	6	14
THRESHOLDS	8	16
	10	18

100 paired items  
standard frequency - 1150 Hertz.

second tone ranges from 5 to 25 cycles higher or lower than the standard frequency. With each item, the test subject makes a pencil-and-paper judgment as to whether the second tone is "higher" or "lower" than the first. The test paper is hand-scored and the total number of incorrect items is recorded in the subject's record.

#### PHYSICAL EXAMINATION (INDEX 051-070)

A comprehensive standardized physical examination is performed by a physician. Abnormal findings are encoded on a printed outline for each physiologic system. Additional findings warranting comment are described in narrative form. If required, the physical examination is also recoded on a Standard Form 88 and returned immediately to the subject's health record.

Supine and upright blood pressure and heart rate are determined with the subject at rest. This is done on two consecutive days, with a standardized mercury manometer and a 12-centimeter cuff. While the two-observer method of blood pressure measurement would be optimal for statistical standardization, the values determined by a single competent technician have been closely comparable. Personnel limitations have dictated the choice of the one-observer method for LHS. Three readings, systolic (phase 1), significant muffling (phase 4), and final diastolic (phase 5), are recorded. Mean blood pressure (diastolic plus  $1/3$  pulse pressure) is calculated as a basis for comparison.

#### VISION (INDEX 071-072)

In the vision protocol, several parameters are measured to characterize visual acuity, color discrimination, and incipient clinical disease. After both eyes have been prepared with a topical anesthetic, a Schiotz Tonometer is used to measure intraocular pressure. Abnormally high pressures are suggestive of mild or incipient glaucoma and such individuals are referred for applanometry.

At the present time, clinical refraction is performed on the right eye and this value is compared with current prescription lenses. Marked discrepancies are referred to the ophthalmology clinic. The evaluation of one eye is considered usually sufficient for longitudinal analysis. The Bausch and Lomb Ortho-Rater Test measures visual acuity and phorias for both the vertical and horizontal dimensions at both near and far-viewing conditions.

The diameters of retinal vasculature are measured by a standardized technique from a fundus photograph taken with a Zeiss Fundus Camera.<sup>18</sup> The ratio of arterial and venous diameters is being calculated and correlated with age and with systemic blood pressure.

Three tests of color discrimination allow sensitive and reliable characterization of color vision patterns.<sup>19</sup> The Pseudo-Isochromic Plates provide a quick screening device. The more sensitive Farnsworth-100 Hue Test involves the ordering of multiple colored discs.

A complicated scoring procedure allows identification of specific color-sensing deficits. A mid-point of color axes is mapped and recorded. The tracings in Figure 4 illustrate the complexities of

the final analyses. Lastly, a brief examination on a Hecht-Schlaer Anomaloscope determines relative sensitivities to red and green chroma. Table IV summarizes the vision examination.

TABLE IV  
OUTLINE OF VISION EXAMINATION, INDEX 071-072

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I. Tonometry (Schiotz Tonometer)

II. Fundus Vessel Diameter:

Artery/Vein

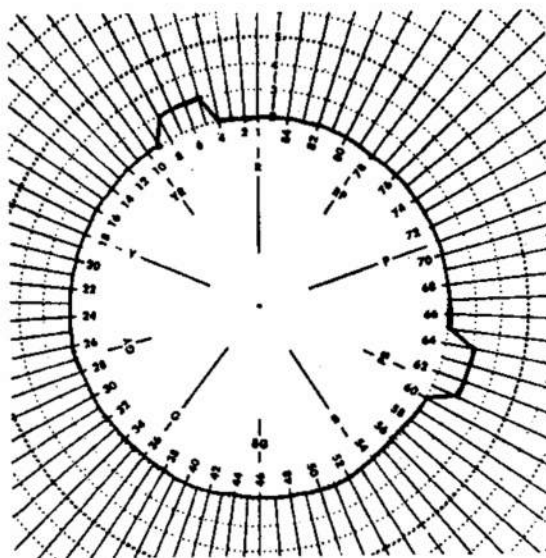
III. Acuity:

Manifest Refraction	Right Eye
Prescription	" "

Orthorater Test

IV. Color Discrimination:

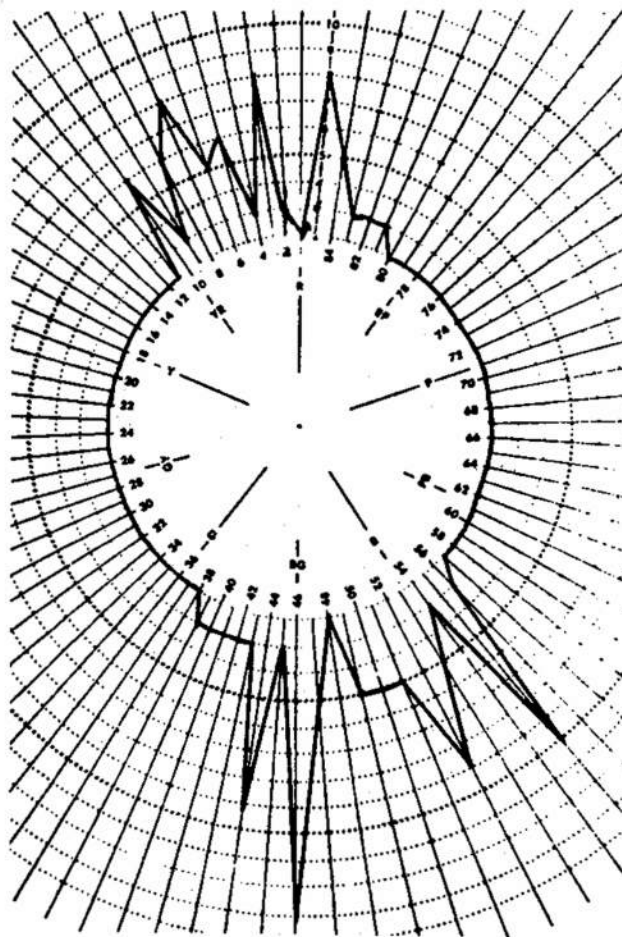
Pseudo Isochromatic Plates  
Farnsworth 100 - Hue Test  
Hecht - Schlaer Anomaloscope



FARNSWORTH-MUNSELL 100-HUE TEST  
For Color Vision

MUNSELL COLOR COMPANY, INC.  
2441 North Calvert Street  
Baltimore, Maryland 21218

a) normal pattern



b) severe blue defective-axes  
midpoint 49

Figure 4. Example Mapping of Color Discrimination Patterns

CHEMISTRY, HEMATOLOGY (INDEX  
081, 082)

Following an overnight fast, 40 milliliters of blood is collected by sterile antecubital venipuncture. The specimen is measured into separate aliquots for processing which includes: a complete blood count (Coulter Counter, Model S), a twelve channel serum chemistry profile (Technicon SMA-12), a serology, and a fasting glucose. Three to five milliliters of serum are frozen (-70°C) and are maintained for future reference in a serum bank. At the same time, a

urine sample is collected for Ames Labstik Test and microscopic analysis.

Two hours after a measured 100 gram glucose challenge, seven additional milliliters of blood are collected for a glucose determination. Serum aliquots have been allocated for assay of Tryglycerides and Alpha-1 antitrypsin, but at present these determinations are not routine. Tables V and VI lists the parameters being tested together with suggestions of the clinical relevance of each measurement.

TABLE V  
HEMATOGRAM, URINALYSIS, AND GLUCOSE TEST, INDEX 081

<u>WHOLE BLOOD:</u>	HEMATOCRIT HEMOGLOBIN WHITE BLOOD COUNT DIFFERENTIAL COUNT	} } } }	Anemia Infection Leukemias Allergy
<u>URINE:</u>	SPECIFIC GRAVITY ALBUMIN SUGAR MICROSCOPIC	} } } }	Kidney Disease Diabetes Infection
<u>SERUM:</u>	GLUCOSE - FASTING GLUCOSE - 2-HOUR POST PRANDIAL GLUCOSE - ABSOLUTE DIFFERENCE BETWEEN TWO TESTS.	} } }	Diabetes Other Hormone Disorder
	AMOUNT OF SERUM IN SERUM BANK.		Future Reference.

TABLE VI  
SERUM CHEMISTRIES, INDEX 082

TOTAL PROTEIN	Infection Nutrition	Liver Disease
ALBUMIN		
GLOBULIN *		
A/G RATIO *		
BILIRUBIN		Muscle Diseases, Tissue Necrosis, Inflammation, Neoplasm
S.G.O. TRANSAMINASE		
LACTIC DEHYDROGENASE		
ALKALINE PHOSPHATASE		
CALCIUM	Parathyroid Disease	Bone and Joint Disease
INORGANIC PHOSPHATE		
URIC ACID		
UREA NITROGEN		
CHOLESTEROL		Diabetes Hyperlipidemia
GLUCOSE		

\* Calculated.

#### MEDICAL HISTORY (INDEX 091-100)

Personal and family medical history is recorded in tabular form, and is oriented more toward the developing of a broad medical biography than toward a current clinical review of systems. The history questionnaire is divided into six sections. A listing of common allergens includes medicine, foods, pollens, and other materials. Personal habits, including cigarette, cigar, and pipe smoking, and coffee and alcohol consumption, are all recorded for five-year intervals since the age of fifteen. By this means, a dose-time curve can be generated for each subject's adult life. Past medical illnesses and surgical experiences are recorded together with age at the time of the illness or procedure. This information is then classified

according to the ICDA-8 coding system.<sup>20</sup> Family medical history is reported for two generations on both maternal and paternal sides of each subject's family. Finally a trauma section requests a listing of accidental injuries and of special trauma related to decompression sickness and/or barotrauma. Each diver completes a separate comprehensive diving history questionnaire which is administered in conjunction with the Aseptic Bone Necrosis Survey.

Obviously, the reliability and completeness of the medical history section are limited by each participant's ability and motivation for detailed recall. The tabular listings have been especially tailored for the comparative analysis which is essential to the LHS.

## ELECTROCARDIOGRAPHY

A standard 12-lead electrocardiogram is performed on each subject with a Hewlett Packard MODEL 1500 electrocardiograph unit. Each tracing is edited and mounted by a technician and is interpreted by a physician who is experienced in electrocardiography. Abnormal tracings are referred to a senior referee. Obvious arrhythmias are noted on the physical examination form. Only when conduction aberrancies are not easily interpreted is vectorcardiography employed for further illumination.

Subtle variances in wave form might easily remain undetected in the process of longitudinal analysis. As Sawyer emphasized in his descriptive report, computer analysis of electrocardiograms would greatly facilitate the identification of these minor variations. Since a computer derives its analyses from standard values, there is a built-in constancy in interpretation. Such constancy befits an epidemiologic study.

While the value of computer electrocardiography is easily recognized, appropriate software has not yet been available at our facility. A computerized ECG terminal will be a timely asset to the LHS.

## SELECTION OF VOLUNTEERS

Almost all of the subjects studied to date have been from one of three groups: submarine personnel attached to the Fleet Ballistic Missile ships of Submarine Group TWO, New London; diving personnel attached to the Escape Training Tank in Groton; and diving students

commencing saturation training at Submarine Development Group ONE, San Diego. Information describing the LHS has been disseminated by the New London Area Coordinator. Interested persons with more than 12 months remaining of obligated military service may volunteer through their medical department representative. The selection of subjects is not ideally randomized. Nevertheless, it has been assumed that a cohort of greater than 1000 submarine personnel will provide representative health profiles. Each subject spends one full working day (0700-1600) at the Laboratory. He returns the following day for a second blood pressure measurement. On this second day he completes a questionnaire in which he evaluates his experience in the program. This evaluation ensures continual scrutiny on the testing techniques in each phase of LHS.

Upon completion, the volunteer receives a wallet-size identification card which states the present intention of recalling each subject at 3-5 year intervals for repeat examination. The techniques for interval recall are being formulated.

A summary of pertinent laboratory results is forwarded to each volunteer when all the test data has been properly recorded and appropriately reviewed.

## COMMENT

Multiphasic screening is becoming a trend in modern medical practice in the United States and has been adopted by many corporate bodies as an integral part of their occupational health

programs. A major drawback to its general acceptance has been related to the follow-up of detected abnormalities. Within the general population, this follow-up represents a major demand upon available medical resources. Submarine and diving personnel as a group are healthier than the general population, owing to their relative youth and rigorous prior selection. Individual changes within the specialized parameters included in the Longitudinal Health Study might well reflect controllable environmental effects. Close attention to the health profile which is being developed will be invaluable to those medical personnel whose task it is to closely monitor the habitability of submarine and diving environments and to the engineers who design the vehicles, equipment, and habitats.

Statistical analysis on the data already collected by the Longitudinal Health Study is pending and will be published in serial NSMRL reports. Our experience, so far, has demonstrated that valuable specialized health parameters can be effectively tabulated and assessed using low maintenance computer software, thus maximizing the role of paramedical personnel in the physical examination process.

The response of the subjects to do this comprehensive-physical examination has been uniformly enthusiastic. The methodology employed in this research work unit deserves close scrutiny as the U.S. Navy seeks to improve its occupational and preventive medicine techniques by effective physical screening and environmental control throughout the Fleet.

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<p>The Longitudinal Health Study is an ongoing medical surveillance program designed to analyze multiphasic health parameters among submarine and diving personnel occupationally exposed to specialized environmental stresses. Traditional as well as specialized health data is tabulated on Hollerith cards for immediate editing and storage and for ultimate retrieval and multivariate analysis. Anticipated and unanticipated biological effects of specialized environmental stresses will be identified with the goal of controlling them. The present report updates previous descriptions by redefining and illustrating the biomedical content of each phase of the study.</p>			

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